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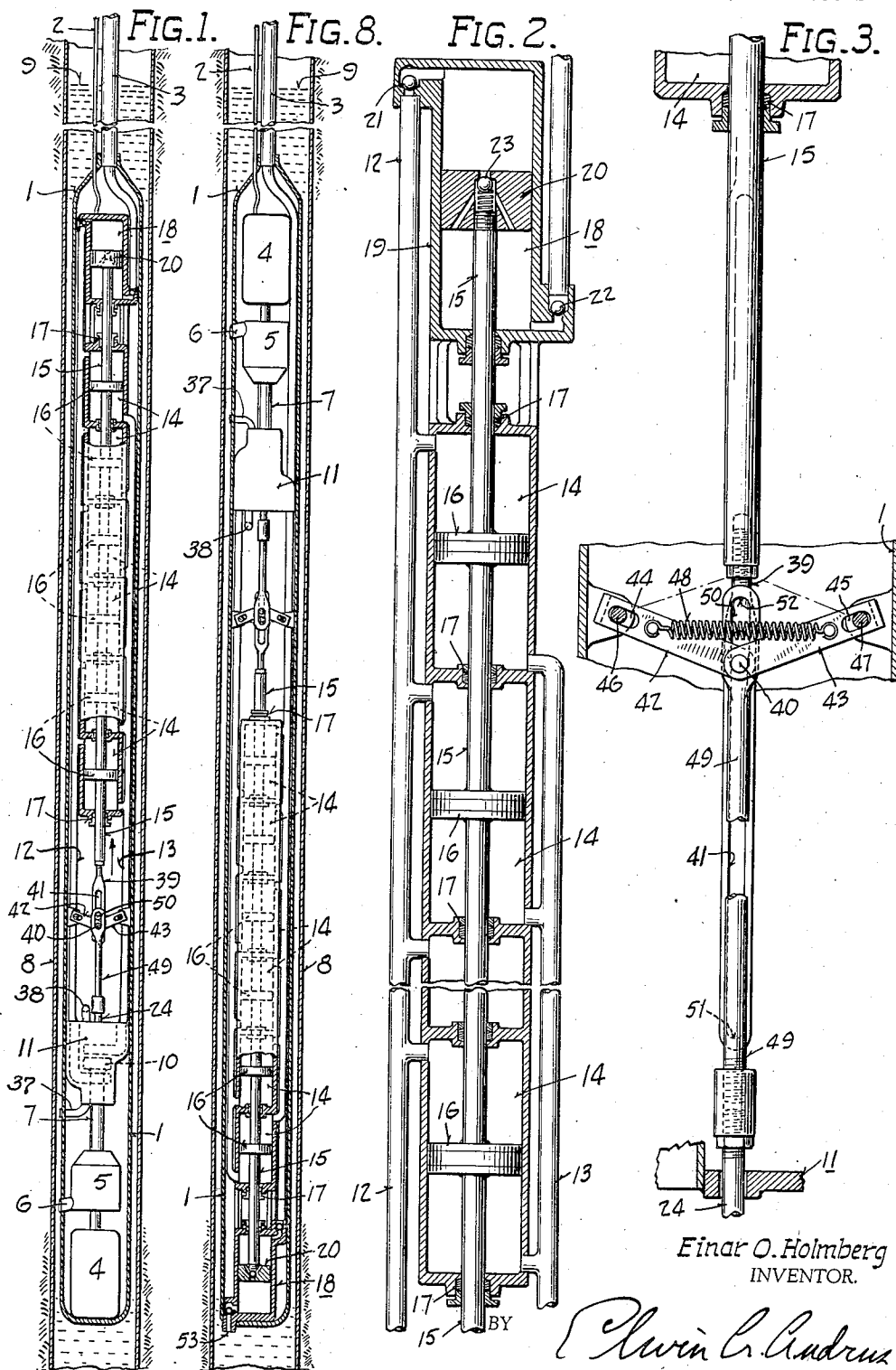
E. O. HOLMBERG

2,220,334

DEEP WELL PUMP

Filed March 21, 1938

2 Sheets-Sheet 1



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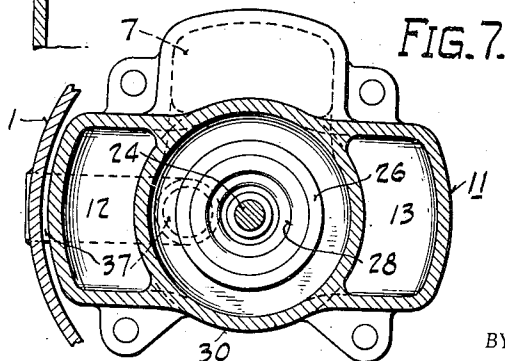
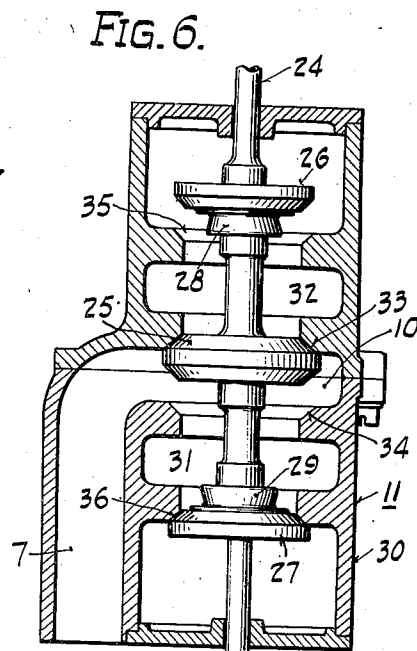
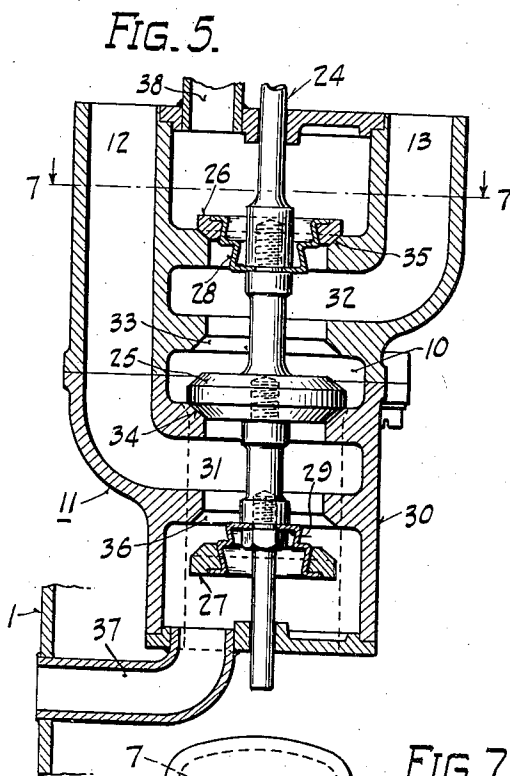
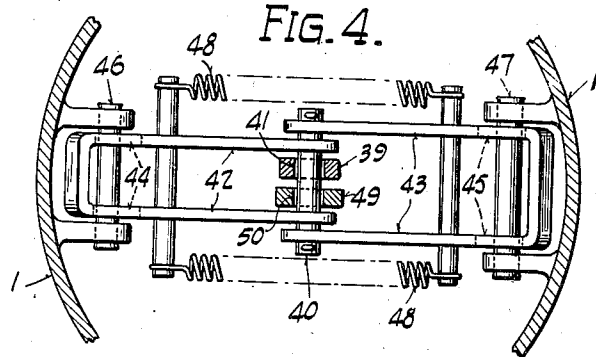
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2 Sheets-Sheet 2



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DEEP WELL PUMP

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5 Claims. (Cl. 103—46)

This invention relates to deep well pumps for pumping oil or other fluids from deep wells.

An object of the invention is to provide an improved deep well pump which is electrically driven and which avoids the necessity for using the sucker rods that have heretofore been extensively employed for actuating oil well pumps.

Another object of the invention is to provide an apparatus in which a power pump utilizes the well fluid to operate a fluid motor which in turn operates the well pump.

In accordance with the invention a low pressure large volume rotary power pump is driven by an electric motor and delivers fluid to a series of pistons in multiple, effecting reciprocation of the plunger of the well pump which delivers a relatively small volume of fluid at relatively high pressure.

Other objects of the invention will be clear from the accompanying description and the drawings in which:

Figure 1 is a longitudinal section through the deep well pump of this invention;

Fig. 2 is an enlarged longitudinal section through the power cylinders and pistons and the crude oil pump;

Fig. 3 is a side elevation of the valve operating mechanism;

Fig. 4 is a top plan view of the valve operating mechanism;

Fig. 5 is a longitudinal section through the reversing valve used to control the distribution of power fluid to the power cylinders;

Fig. 6 is a longitudinal section through the reversing valve taken on a line at right angles to that used for Fig. 5 and showing the valve seated at the other extremity of its travel;

Fig. 7 is a transverse section on the line 7—7 of Fig. 5; and

Fig. 8 is a longitudinal section through another embodiment of the pumping unit which may be more desirable under certain conditions.

In providing an electric motor driven deep well pump the problem of utilizing the high speed rotary drive for pumping has been a difficult one to solve. If a rotary well pump is used, it will necessarily have small clearances in order to work against the high pressure head of the fluid, and would soon be ruined by sand or grit in the crude oil or liquid pumped. A centrifugal or turbine type pump would be free from this trouble since clearances do not need to be kept small, but these pumps are adapted to pump large quantities of fluid against a low head and are not so suitable for pumping a small quantity against a high

head, and it is this last which a deep well pumping unit must do.

One of the objects of the invention is to provide a pumping unit in which a centrifugal or turbine pump direct connected to an electric motor is used to supply a large volume of fluid at low pressure, this fluid being then employed to drive a reciprocating hydraulic motor which actuates a reciprocating pump to force well fluid to the surface of the ground. In this way use is made of the superiority of power transmission by electricity as compared to transmission by sucker rods; the electric motor is directly connected to a high speed rotary pump which is of such nature as not to be injured by the passage of sand or grit through it; and full advantage is taken of the well recognized suitability of reciprocating pumps for pumping from deep wells.

Referring to the drawings in which the embodiments shown are adapted particularly to pump-
ing from oil wells and particularly to Fig. 1, the
pumping unit comprises a shell 1, from which an
electric cable 2 and a tubing string 3 for the
pumped fluid lead to the surface of the earth.
An electric motor 4 is direct connected to the
impeller of a turbine or centrifugal pump 5 which
takes in crude oil through conduit 6 and dis-
charges it through conduit 7. In using this unit
in a well 8 the inlet 6 will be submerged a suit-
able distance below the oil level 9. Conduit 7
terminates in port 10 in the reversing valve 11.
Conduits 12 and 13 lead from the reversing valve
11 to the upper and lower ends respectively, of
cylinders 14, of which six are shown in the em-
bodiment illustrated. These cylinders are ar-
ranged in line and are traversed by a piston rod
15 which carries pistons 16 reciprocable within
the cylinders. Suitable packings 17 seal the pis-
ton rod where it passes through the ends of the
cylinders. The crude oil pump 18 for pumping
crude oil to the surface of the ground comprises
a cylinder 19, a piston 20 connected to the piston
rod 15, and ball check valves 21, 22 and 23. Con-
duit 12 communicates with the upper end of cyl-
inder 19 through check valve 21 so that use is
made of the pressure developed by rotary pump
5 to supply oil to the crude oil pump 18 on its
down stroke.

The reversing valve 11 comprises a valve stem
24, a disc shaped valve member 25 rigidly secured
to the valve stem, and annular valve members 26
and 27 secured to the valve stem by the resilient
members 28 and 29. The reversing valve body 30
is provided with a port 10 connecting with fluid
conduit 7 and ports 31 and 32 communicating,

respectively, with fluid conduits 12 and 13. The valve seats 33 and 34 are somewhat larger than valve seats 35 and 36 so as to give an unbalanced pressure tending to keep the valve seated in whichever position it may be.

When the valve occupies the position shown in Fig. 5, crude oil from the rotary pump 5 passes through conduit 7, and ports 10 and 32 to the conduit 13 which conducts it to the lower ends of the cylinders 14. Oil in the upper end of the cylinders 14 passes down conduit 12 and through port 31 to conduit 37 from which it is discharged back into the well. Under these conditions the pistons 16 and the piston rod 15 are driven upwards. The cylinders 14 are as large in diameter as the size of the well permits and take crude oil in parallel from pump 5. A large volume of fluid is therefore required to cause substantial upward motion of the piston rod. Only a moderate pressure is required, however, to exert a very considerable force on the piston rod since the pressure is applied to the comparatively large areas of each piston and the forces exerted on the pistons are all added together by virtue of the attachment of all pistons to the common piston rod. Consequently the large volume of low pressure fluid from pump 5 is used to produce a considerable force on the piston rod 15, and this in turn is used to drive pump 18 to pump a small volume of crude oil against the high pressure exerted by an oil column reaching from the pump to the surface of the ground.

As the pistons 14 near the upper end of their stroke, the reversing valve is thrown to the position shown in Fig. 6 by means which are described hereinafter. In this position the flow of fluid to cylinders 14 is reversed and the pistons within the cylinders are forced downward, the oil below the pistons being discharged back into the well through conduit 13, the reversing valve, and conduit 38.

The reversing valve is operated by the motion of the piston rod 15 to which an extension 39 is attached. A pin 40 passes through a slot 41 in rod 39 and through the intersection of two forked toggle arms 42 and 43. Slots 44 and 45 at the outer ends of toggle arms 42 and 43 engage fixed pins 46 and 47. Springs 48 tend to cause the toggle arms to depart as far as possible from the straight line joining pins 46 and 47. The valve stem 24 is connected to the reversing valve mechanism by rod 49 with slot 50 through which pin 40 passes.

When the valve and the valve operating mechanism have the configurations illustrated in Figs. 3 and 5 the distribution of fluid to cylinders 14 is such as to cause upward motion of piston rod 15 and its extension 39. No effect upon the valve operating mechanism is produced until the upward motion of the pistons brings the lower end 51 of slot 41 into contact with pin 40. This forces pin 40 and toggle arms 42 and 43 upward and stretches spring 48. Since the pin 40 is free to move upward in slot 50, no motion is imparted to rod 49. During this period the valve is held on its seat by the unbalanced hydraulic pressure acting on it, for as previously pointed out, the valve seats should be made of slightly different areas so that the unbalanced pressure on the valve tends to keep it seated. Continued upward motion of the piston rod 15 and its extension 39 ultimately carries the toggle arms 42 and 43 past their dead center position, after which springs 48 cause them to move pin 40 rapidly upward. The pin comes into contact with

the upper end 52 of slot 50 and forces rod 49 and valve stem 24 upward thus throwing the reversing valve to its other position as shown in Fig. 6 and reversing the motion of the pump plunger. Toward the end of the downstroke of rod 15 the upper end of slot 41 engages pin 40 and forces it downward past the dead center of toggle arms 42 and 43, thus causing the valve to be shifted again.

In wells where salt water is present along with the oil the passage of a mixture of the two through a centrifugal or turbine pump produces an emulsion which it is difficult to separate into its constituents. With the embodiment illustrated in Fig. 1, all the oil pumped to the surface by pump 18 has first passed through the rotary pump 5 and may have been emulsified to a greater or lesser extent. In the embodiment illustrated in Fig. 8 the pump 18 takes oil directly from the well through conduit 53 and pumps it to the surface. The centrifugal or turbine pump 5 simply recirculates crude oil taken from and discharged back into a region of the well above that which supplies oil to pump 18. By suitably restricting communication between these regions of the well only an insignificant amount of emulsified fluid will find access to pump 18 through conduit 53. If desired, an entirely closed circulating system can be made for oil passing through the rotary pump 5, the reversing valve 11, the cylinders 14, and back through the reversing valve to the rotary pump, and this closed system can be filled with a fluid of any desired properties.

I claim:

1. In a submersible unit for pumping fluid from a deep well, the combination of a piston rod, a plurality of pistons mounted thereon, cylinders in which the pistons travel, means for admitting fluid under pressure to corresponding ends of the cylinders so that the forces exerted on the pistons by the fluid pressure will be added together, a reciprocating pump driven by the piston rod, said reciprocating pump being adapted to pump the desired quantity of well fluid against a pressure head corresponding to the height to which it is desired to pump the fluid, a rotary motor, a rotary pump driven by the rotary motor and adapted to pump fluid at a rate in excess of that at which it is desired to remove fluid from the well but at a lower pressure than would suffice to elevate the fluid from the well, means to direct the fluid pumped by the rotary pump alternately to opposite ends of the cylinders in which the plurality of pistons mounted on the piston rod travel so as to produce reciprocating motion of the piston rod, an inlet from the well to the rotary pump, and an outlet from the rotary pump to the means used to control the distribution of the fluid which it pumps.

2. In a submersible unit for pumping fluid from a deep well the combination of a reciprocating pump adapted to pump well fluid at the desired rate against the necessary head, a rotary pump adapted to pump a larger quantity of well fluid against a lower head, a rotary motor to drive the rotary pump, and a reciprocating hydraulic motor adapted to drive the reciprocating pump and to be driven by the fluid pumped by the rotary pump, the reciprocating hydraulic motor comprising a plurality of cylinders arranged in tandem, pistons movable therein, and a common piston rod to which the pistons are secured.

3. A submersible pump for pumping fluid from a deep well which comprises a hydraulic motor

with a plurality of cylinders arranged in tandem, pistons movable within said cylinders, a common piston rod to which the pistons are secured, a reciprocating pump driven by the motion of the piston rod, a rotary electric motor, a rotary pump driven by the rotary motor and operating on the fluid from the well, a reversing valve for controlling the distribution of fluid pumped by the rotary motor, fluid conduits from the reversing valve to the cylinders arranged in tandem, said conduits being arranged to conduct fluid to and exhaust it from the corresponding ends of all the cylinders, and means controlled by the motion of the piston rod for throwing the reversing valve as the piston rod nears each end of its stroke, said rotary pump also supplying well fluid under initial low pressure to said reciprocating pump.

4. A submersible unit for pumping fluid from

a deep well, comprising an electric motor, a reciprocating well pump, a reciprocating fluid motor for driving said well pump, and a high speed large volume low pressure rotary pump driven by said electric motor and operating on fluid from said well for driving said reciprocating fluid motor.

5. A submersible unit for pumping fluid from a deep well, comprising an electric motor, a reciprocating well pump, a reciprocating fluid motor for driving said well pump, a high speed large volume low pressure rotary pump driven by said electric motor and operating on fluid from said well for driving said reciprocating fluid motor, and means for supplying low pressure well fluid from the rotary pump to the reciprocating well pump.

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